

An Exploratory Study of Credibility Issues in Astronomy Press Releases

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Summary

Current developments in the media marketplace and an increased need for visibility to secure funding are leading inevitably to faster, simpler and more aggressive science communication. This article presents the results of an exploratory study of potential credibility problems in astronomy press releases, their causes, consequences and possible remedies. The study consisted of eleven open-ended interviews with journalists, scientists and public information officers. Results suggest that credibility issues are central to communication, deeply integrated into the workflow and can have severe consequences for the actors (especially the scientist), but are an unavoidable part of the communication process.

Introduction

Science communication operates in the modern media marketplace and competes for headlines with politics, business, sports, crime and large commercial communicators such as the entertainment industry. Science communication is partly a political tool and the pressure on the communicator to deliver is greater than ever. Due to the very nature of public communication, the temptation to overstate the importance of scientific results or to take credit for more than is deserved is great. Two of the more well known examples of credibility problems within astronomy and physics are the "NASA Mars meteorite" case (Kiernan 2000) and the "Cold fusion" case (Gregory and Miller 1998, p. 61).

The extent of the damage done to the public perception of science and scientists by examples like these is very difficult to measure. A recent public opinion survey (European Commission, 2005) has shown that Europeans generally see scientists as being credible and having a positive impact on society. Journalists scored poorly in the survey, but still much better than politicians who were almost at the bottom of the scale.

Many scientists have the impression that science reporting is inaccurate and that science news is often overstated (Shortland and Gregory 1991, p. 8; Dunwoody 1986, p. 11). This perception has, in the case of astronomy, been shown to be false by Shaefer et al. (1999), who found that none of 403 evaluated newspaper articles on astronomy significantly misled the reader. Furthermore, most errors in the evaluated articles could be attributed to the fact that they were reporting on front-line science, where no reliable conclusion has yet been reached. Scientists and journalists can also have quite different perceptions of the term accuracy, and thus "accuracy" for journalists is usually missing the required level of detail for scientists (Peters 1995).

Credibility in science communication is one of the most actively discussed issues in science communication today: *'How far can we, in the name of science communication, keep pushing, or promoting, our respective results or projects without damaging our individual, and thus also our collective credibility?'* (Robson 2005, p. 162). As science communicator Robert Hurt states (interview 4): *'In public affairs you are pulled between two poles: sensationalizing the results and correctness.'* However, serious

studies about this important, but rather elusive, topic are difficult to find in the literature.

How widespread are credibility problems in astronomy press releases? What factors cause these credibility problems? What are their consequences and how can they be reduced? It is the purpose of this exploratory study to answer these questions.

The topic of astronomy was chosen partly for its inherent fascination for the public and partly as it is a fundamental science — one where credibility issues do not involve risks to human lives or substantial commercial interest as compared with fields such as health care (Madsen 2003).

This paper only examines the credibility of the communication of scientific results, and not the credibility of the actual scientific results themselves. We thus assume that the peer-review process produces credible scientific results, though some scholars question this claim (Russell 1986, p. 93; Nelkin 1995, p. 150; Gregory and Miller 1998, p. 168). The communicated scientific results, by their very nature as cutting-edge information, may of course later be proved wrong, but this is how the scientific process works. The question whether the com-

municated results are “true” to the actual scientific results is here treated independently of the intrinsic quality and scientific importance of the results themselves.

Study Design

This exploratory study was inspired by the panel discussion, ‘Keeping our Credibility: Release of News’, held at the Communicating Astronomy with the Public 2005 conference at the European Southern Observatory in Munich in June 2005.¹

We chose to examine the problem of credibility in astronomical press releases from the perspective of the actors in the science communication process: scientists, journalists and public information officers at large governmental and intergovernmental scientific organizations. According to Madsen (2003) and sources quoted therein, nearly 50% of all reported science news in the media result directly from press releases, making this particular way of communicating science news very important.

A qualitative rather than a quantitative approach was chosen because we, as in parallel studies (Treise and Weigold 2002), wanted to identify and understand the issues as experienced by the actors themselves. The qualitative approach allowed us to adapt to many kinds of responses and to explore uncovered issues in greater detail. Furthermore, we assumed that by conducting face-to-face interviews we could ask more penetrating questions on sensitive issues and so explore the more important issues in greater detail.

Care should be taken if the astronomy-related results presented here are used to draw broader conclusions about science communication in general. However, this paper may serve as a basis for designing quantitative studies of the credibility of general science communication.

Research Questions

Based on our preliminary studies, we posed the following five research questions:

1. How do the communication actors define credibility and credibility problems in science communication?
2. In which situations do the communication actors experience credibility problems?
3. How do the communication actors experience the consequences of credibility problems?
4. When should the dissemination of scientific results to the public take place?
5. Would it be useful to formulate a ‘code of conduct’ for press releases in astronomy and if yes, how might it look?

These five research questions formed the basis for the topics to be covered during the interviews.

Method

Eleven open-ended, in-depth interviews with a semi-structured interview guide approach (Kvale 1996, p. 129) were conducted with science communication actors². The topics of the interviews were specified in advance, but the sequence of the questions and responses from the interviewees were not restricted to choices provided by the interviewers.

The authors conducted eleven face-to-face interviews in person (one interview was conducted with two persons who are close collaborators³) in Munich, Baltimore, New York and Boston and one interview was conducted by telephone. Each interview lasted approximately one hour and was recorded digitally with the verbal permission of the interviewee.

Interviewees were chosen to match one of the following profiles:

- Scientists closely relating to the work of public information officers, either as scientific support in the development of press releases (outreach scientists) or as evaluators of the public information officers’ work.
- Science journalists specializing in astronomy.
- Public information officers from large governmental scientific institutions.
- Scientists who are otherwise deeply involved with science communication.

The public information officers and scientists were selected from two of the largest governmental and intergovernmental astronomy research organizations in Europe and the United States of America, namely the European Southern Observatory (ESO) and the National Aeronautics and Space Administration (NASA).

We followed seven steps in the analysis of the interviews:

1. Reduction of raw information (selective transcription): After all the interviews were completed they were each transcribed selectively, i.e. not verbatim, by one of the authors. Statements that were not deemed relevant to the posed research questions were omitted.
2. Re-reduction of raw information (selective retranscription): Each interview was then transcribed again using the same method, but by another of the authors to reduce the risk of missing important information.
3. Identification of interesting themes: Themes in each interview were then identified, meaning that the transcript was examined for descriptions, ideas, patterns, observations or interpretation of phenomena that could shed light on our research questions.
4. Comparison of identified themes: Recur-

ring themes among the different actors were found.

5. Condensation of interviews to statements: Each interview was then further reduced with the aid of the identified themes to a list of statements.
6. Validation of statements: To ensure that the statements did not misrepresent the interviewee the statements were validated against the recorded interviews.
7. Approval of statements: Each list of statements was sent to the interviewee for approval to validate the reduction process described above and to give them a chance to comment.

Results

Finding 1: Credibility is primarily defined as being honest and doing your homework.

Eleven out of twelve of the interviewees largely defined credibility in science communication as being honest and doing your homework well. Interestingly, Heck (interview 3) defined credibility as, ‘*credibility occurs if the message that you conveyed have been received credible by the receiver*’, which implies that the communicator is responsible for tailoring the message in such a way that it is well received.

Hype and exaggeration was generally defined by all interviewees as taking credit for more than you deserve by overstating importance of science results e.g. by increasing visibility overly.

Finding 2: Credibility issues are ubiquitous and integrated into the public information officer (PIO)-Journalist interaction.

There is a general view that a certain amount of exaggeration of scientific findings in press releases is necessary to reach the general public (science journalist Schilling, interview 9; science communicator Villard, interview 11; scientist/communicator Tyson, interview 10). The media are used to and even expect a certain amount of overstatement, as stated by Schilling (interview 9), ‘*There is hype everywhere and everybody is doing it ... every serious science journalist knows that press releases are made by public information officers who emphasize their own organization.*’ Science journalist Lorenzen (interview 7) goes as far as to say, ‘*It is the responsibility of the journalist to check the press releases.*’

Even though overstatements in press releases are normally perceived as harmful by the scientific community, the view, especially among science communicators and journalists, is that some overstatement is unavoidable when communicating a technical scientific result to the public. All interviewees agree that high accuracy is vital when communicating to the general public, but ‘*[...] the level of accuracy is irrelevant if no one pays attention. To make something interesting and glamorous is not*

hype — hype is when you take credit for more than you deserve,’ (Villard, interview 11).

Public information officers are juggling daily to find a sensitive balance between correctness and overstatement, and they constantly need to walk a tightrope to get news out to the media. If press releases are accurate but uninteresting, they will not receive media attention, but if PIOs sacrifice accuracy while injecting colour the press releases lose credibility with journalists and are not used. As science communicator Watzke (interview 1) says, *‘[PIOs] end up walking a line, because you want to be as interesting and provocative as possible without being wrong.’*

Although scientific organizations jostle to be heard by the same media and are sometimes in competition for the same funding, all the interviewees agree that if competition between organizations becomes unethical it may damage the credibility of the whole community (science communicator Edmonds, interview 1; scientist Leibundgut, interview 5). Hurt (interview 4) states this clearly: *‘Any chink in the armour of credibility can make the entire scientific community vulnerable to attack.’*

It is evident that there is a great interest in, and concern for, credibility among the communication actors in general. As stated by Villard (interview 11), *‘once lost [credibility] is very hard to achieve again.’* It is a topic that is known to be very sensitive and of high priority to all involved communication actors. Great effort is put into producing science communication that is as accurate and as credible as possible (Watzke, interview 1; scientist Livio, interview 6; science communicator Madsen, interview 8; Hurt, interview 4).

Finding 3: Credibility problems are most often caused by an intense need for visibility driven by personal or organizational desires for recognition or financial gain.

As stated by scientist/communicator Heck (interview 3): *‘Behind hype is the problem of visibility and recognition — the fight of organizations, laboratories or people for money.’* This development inevitably leads to science communication with more spin, more push and a shorter elapsed time from scientific results to publicly communicated results.

The pressure is applied from different sides: from the organization itself — often from management, from PIOs and also from scientists. While many scientists try to be modest when they publish their results, the increased competition in the scientific community may push them to overstate their results to become more visible, thereby attracting more funding and gaining recognition (Leibundgut, interview 5). As stated by Madsen (interview 8), *‘in the “conventional wisdom” scenario, the scientist is the guardian of “truth” and objectivity, urging caution and moderation. [...] But this is a simplistic scenario. I have seen several cases where the scientist fell into the trap of serious “overselling” or hype and the press officer had to exercise the necessary restraint.’*

Finding 4: At least five separate factors may contribute towards credibility problems in press releases.

When trying to “dissect” the cause of credibility problems, we found that it is possible to list (at least) five different distinct, but related, causes with underlying motivations that generally fall into one of two categories: factors that contribute to making the organization look better than it deserves and factors that make other organizations look worse than they merit. The causes are:

1. Using too high a level of communication effort for the level of scientific importance.
2. Using wording that does not correspond to the level of scientific importance.
3. Letting unscientific factors dictate the timing of the publication of a press release.
4. Omission of references to other scientists’ work.
5. Unjust comparisons with other facilities.

1. The level of communication effort

Naturally, all scientific findings are not of equal scientific significance. The PIO has to choose from different levels of communication effort to emphasise the finding and convince the media to run the story given. This decision will be based on a subjective assessment of the scientific importance as determined by the PIO, the scientists and possible internal organizational boards. The chosen communication effort may have a great influence on the resulting visibility of the story in the media.

We have chosen to define the level of effort with which a science press release is communicated and distributed by a “press release visibility scale” (see Figure 1).

When releasing a given result, a PIO will choose a level of effort according to the importance of the given result. The scale, as defined here, consists of seven steps, with magnitude 7 being the highest level of effort an organization can put into communicating a result. If too high a level is chosen relative to the story’s scientific importance, credibility problems may occur (Nelkin 1995, p. 161). The higher the level of effort the more solid the science case and the evidence have to be. Equally, the higher the level of effort the greater the need for a corrigendum if the science is later proven wrong — and the actual correction should have a commensurate visibility (Heck, interview 3).

- Magnitude 7 — Live televised press conference with the presence of a high-ranking political figure: Only major scientific discoveries are endorsed by politicians, whose presence will pull the media in even more strongly. Normally this news will be based on an accepted peer-reviewed paper to be published in a prominent science journal like Science or Nature.

The Press Release Visibility Scale	
Magnitude 7:	Live televised press conference with presence of a high ranking political figure
Magnitude 6:	Live televised press conference
Magnitude 5:	Press conference
Magnitude 4:	Media teleconference
Magnitude 3:	Press release
Magnitude 2:	Photo release
Magnitude 1:	Web-only posting

Figure 1. Press release visibility scale.

- Magnitude 6 — Live televised press conference: If a result is released via a live televised press conference this effort tells journalists that the scientific institution believes the scientific finding is of major importance.
- Magnitude 5 — Press conference: Press conferences that are not televised live are likely to receive less attention than their live televised counterpart, mainly because they require journalists to gather in person in one place.
- Magnitude 4 — Media teleconference: The media teleconference allows journalists to be in close contact with the scientist without having to travel. A scientist will give a presentation and journalists may ask questions afterwards.
- Magnitude 3 — Press release: Press releases are the most frequently used way of communicating science news that presents a scientific discovery of significant importance to the general public. Press releases are sent out via distribution lists that cover hundreds of journalists and news media. If a wire service picks up a press release many local newspapers will pick up the story.
- Magnitude 2 — Photo release: Photo releases do not usually represent major scientific discoveries, but contain aesthetic images. Even though the scientific content is relatively low, a photo release may still achieve considerable media attention, and may for instance appear on the front page of the New York Times which happened for an image of Mars⁴ taken by the Hubble Space Telescope (Villard, interview 11). There is rarely a scientific paper to back up a photo release.
- Magnitude 1 — Web-only posting: Web stories, posted only on the scientific institution’s website, contain news or information from the scientific institution that may only be of interest to a smaller audience. The end user needs to be active to “pull” the material from the scientific institution’s website.

It is important to note that the press release visibility scale describes the effort level chosen by PIOs to emphasize a scientific result, and

not the level of attention the press release will actually receive in the media, as this is partly determined by a number of additional external factors.

2. The wording of a press release

It is necessary for the public information officer to make science results understandable for the general public by simplifications and analogies (Heck, interview 3; Villard, interview 11; Livio, interview 6; Tyson, interview 10; Hurt, interview 4); Madsen, interview 8; Watzke, interview 1; Edmonds, interview 1). However, the wording can be used to overstate claims and thus increase the visibility of a scientific finding. It can be tempting to omit a question mark in a headline and also to omit the caveats and qualifiers that are really necessary. As Livio (interview 6) says, 'when using words like "may", "could", "possible", etc., the news media does not find these stories exciting enough, and therefore do not print them [...].'

Another aspect of the critical use of wording is seen as "superlative saturation". This is recognized as part of the established process (Tyson, interview 10) and occurs when PIOs focus on the parts of science that contain results that justify superlatives like "biggest", "fastest", "first", etc. The superlatives are often factually correct and are added to catch the attention of journalists working under heavy time pressure and deadlines. It is always possible to find at least one superlative for even the smallest science results. The resulting "superlative saturation" can make it difficult for journalists to separate "big story" press releases from smaller ones.

3. Dictating the timing of a press release

The timing of a press release is a factor that can affect the visibility of a given science story greatly. The timescales of the scientific process and the communication process are vastly different. Science can take years to materialize and the communication of the result can be over in days. As stated by Lorenzen (interview 7), 'Peer-reviewing is a slow process — I think you have to communicate fast.' Conflict over timescales is one of the inherent potential flashpoints in the scientist-journalist interaction (see Valenti 1999).

The timing of a press release can be the cause of credibility problems in at least three areas:

1. The timing may be used as a political tool: A press release can, for instance, be timed to coincide with a vote on funding for a scientific organisation. As a scientist, Fosbury points out (interview 2): 'When a professional in, I guess, any science sees a press release they think the organization must have a grant application review coming up and therefore they are trying to create some kind of event around this.' This can raise concern about abusing science results for political motives among the journalists. Heck (interview 3) gives an example: 'Some years ago an

announcement that life had been found on Mars made all the headlines and even triggered some words from the then US President (Clinton). Interestingly, this took place shortly before a NASA budget was to be approved by the US House of Representatives or by the Senate. Of course, no life has ever been found on Mars, but the subsequent rectification passed almost unnoticed in the news.'

2. A press release can be forced out before a peer-reviewed paper exists. This bypasses the scientific process and opens up a whole range of potential credibility problems (Tyson, interview 10).
3. A press release can be timed so as to interfere with a press release or an event from a competing scientific organization. Not only is this unethical and counterproductive for science in general, but, as in case 1 above, it raises concern about the real motives behind the press release.

4. Omission of references to other scientists' work

Giving proper credit to earlier work in the same field is another stress point in the battle between the communicator's need for conciseness and the scientist's need for completeness (Edmonds, interview 1). There is no doubt that this decision is very subjective. Credibility problems may arise if credit is taken for work that has been done by others or a conscious decision is taken to omit references to earlier work where it is obvious that it ought to be acknowledged.

5. Unjust comparisons with other facilities

Comparisons of scientific and technical abilities are a standard part of public communication. It is most probably unavoidable and, to some extent, a healthy part of justifying the funding spent on scientific projects. A newly funded project is supposed to be an improvement, incremental or better, on existing projects. Credibility issues can occur if this is done in an unjust way or so as to diminish other projects (Hurt, interview 4; Villard, interview 11).

Finding 5: Loss of credibility mostly affects the scientist

We find that individual scientists stand to lose more credibility than an entire institution, a reporter or a PIO (Schilling, interview 9). So it is natural to find that scientists are more concerned about this topic than other actors. Scientists know that negative reactions from their peers can have devastating consequences for their career, as it might for instance get harder to publish articles, find collaborators or get better positions (Livio, interview 6; Tyson, interview 10).

Finding 6: Refereeing either by the main scientist, an internal refereeing board or an external refereeing board can reduce the risk of credibility problems.

Interviewees mentioned that the reluctance of scientists to communicate arose from a fear of losing credibility with their peers (Fosbury, interview 2). One way to improve the scientists' view of communication via press releases is to encourage them to collaborate as much as possible and to understand the different priorities operating when communicating with the public. It is also necessary that the main scientist involved approves a press release (Watzke, interview 1).

If a press release is run past an internal refereeing board before its public release, some factors that are known to increase inaccuracy can be eliminated. This means that there is less risk of oversimplified results, incorrect analogies, problems of a political nature and other factors that can harm credibility. Internal refereeing also helps scientists maintain credibility with their peers, which, as mentioned above, is important for the scientist's willingness to communicate (Edmonds, interview 1; Hurt, interview 4; Madsen, interview 8; Watzke, interview 1).

Finding 7: The lack of a peer-reviewed scientific paper makes a press release more vulnerable to loss of credibility.

To all interviewees it is important that the result has been peer-reviewed prior to public dissemination, as this is vital to increase the scientific accuracy of the communication. In its most extreme form this principle is implemented by some journals, like *Science* and *Nature*, in the form of the Ingelfinger rule (Toy 2002). The rule says that scientific results must not be published elsewhere (including public dissemination and electronic preprints) before the paper has been published by the journal it was submitted to. The rule was invented partly to protect the (legitimate) commercial interests of the publishers of scientific journals and partly to control the timing of the release of a given scientific result into the public domain as a response to the increasing external pressure. The original intentions of the Ingelfinger rule make some sense, as it seems fair for a publication to protect the newsworthiness of its stories and to put a brake on the accelerating pace of the public dissemination of science results. However, the embargo system also has negative effects (Kiernan 2000; Marshall 1998) that lie beyond the scope of this paper.

The need for a refereed scientific paper backing a press release increases as the claims become more significant. If no paper is available to support significant scientific claims, it makes a press release more vulnerable to loss of credibility, as the claims may more easily be undermined as the normal scientific process has been bypassed. It is risky to use high levels of communication efforts without a peer-reviewed scientific paper in the background (Tyson, interview 10; Fosbury, interview 2).

Conclusions

Credibility issues are found everywhere in scientist-PIO-journalist interactions and are deeply integrated into their workflow. Overstatements are, to some degree, accepted and recognized as a necessity for the communication process.

All actors also recognize the sensitivity of the issue and know that the issue can have severe consequences to the actors. The real reason behind credibility problems is an intense need for visibility that is driven primarily by the desire for recognition or funding.

Credibility problems in press releases can be caused by using too high a level of communication effort, by overstating scientific claims, omitting qualifiers and saturating the text with too many superlatives, by dictating the timing of a release for political motives, by announcing the finding to the public before the peer-reviewing process has had a chance to work or to time the issuing of a release in order to interfere with other press releases, by omitting references to other important work in the same field, or by making unjust comparisons with other projects.

Credibility problems often have the greatest negative implications for the scientists. However, internal refereeing and the peer-reviewing system can reduce the risk of credibility problems for all actors.

To make these findings applicable to practical science communication it is necessary to synthesize them into guidelines that may aid the work. Nine specific recommendations are listed below. These can be seen as a suggestion for a “code of conduct for astronomical press releases” that astronomical organizations could adapt as guidelines, or as an ethical charter, to help to minimize credibility problems and to evaluate cases of questionably aggressive science communication.

Some of these recommendations are aimed directly at ensuring scientific accuracy in press releases announced to the public; others are included to ensure credibility within the scientific community, and among public information officers and scientists. As is natural in such a diverse field as press releases in astronomy, there is much room for interpretation in each recommendation and valid exceptions to these guidelines can naturally also exist.

In conclusion, we recommend that:

1. Scientific results should be peer-reviewed prior to public dissemination.
2. Press releases should be validated by the main scientist.
3. Press releases should be validated by an internal institutional refereeing body.
4. Substantial work by others in the same field should be acknowledged.
5. The incremental nature of the scientific process should be mentioned if at all possible.
6. If the science or the press release turns out to be incorrect a correction of the web version of the release should be posted or if the release contains significant mistakes a correction release should be issued.
7. The level of communication effort should

fit the level of importance of the science as determined by the involved scientists, PIO and the internal refereeing board of the organization.

8. The wording in the release text should match the level of importance of the science and include the relevant qualifiers.
9. A press release should not be intentionally timed to counteract press releases from competing organizations.

Appendix

The following individuals were interviewed for this project:

- Dr Peter Edmonds (PIO), outreach scientist at Chandra X-Ray Observatory (NASA), interviewed in person in Boston, on 3 November 2005 (interview 1).
- Dr Robert Fosbury (scientist), head of Space Telescope European Coordinating Facility (ESO/ESA), interviewed in person in Munich, on 7 November 2005 (interview 2).
- Prof. André Heck (scientist/communicator), first-class astronomer at Strasbourg Astronomical Observatory, interviewed in person in Boston, on 3 November 2005 (interview 3).
- Dr Robert Hurt (PIO), imaging specialist at Spitzer Space Telescope (NASA), interviewed in person in Boston, on 4 November 2005 (interview 4).
- Dr Bruno Leibundgut (scientist), head of Office for Science at European Southern Observatory, interviewed in person in Munich, on 25 October 2005 (interview 5).
- Dr Mario Livio (scientist), outreach scientist at Space Telescope Science Institute (NASA), interviewed in person in Baltimore, on 31 October 2005 (interview 6).
- Mr Dirk H. Lorenzen (science journalist), senior science reporter for German Public Radio and major newspapers, interviewed in person in Munich, on 7 November 2005 (interview 7).
- Mr Claus Madsen (PIO), head of ESO Public Affairs Department, interviewed in person in Munich, on 28 October 2005 (interview 8).
- Mr Govert Schilling (science journalist), science correspondent, interviewed by telephone from Copenhagen, on 16 November 2005 (interview 9).
- Dr Neil deGrasse Tyson (scientist/communicator), director of Hayden Planetarium, interviewed in person in New York, on 31 October 2005 (interview 10).
- Mr Ray Villard (PIO), public information manager for Space Telescope Science Institute (NASA), interviewed in person in Baltimore, on 31 October 2005 (interview 11).
- Ms Megan Watzke (PIO), press officer for the Chandra X-Ray Observatory (NASA), interviewed in person in Boston, on 3 November 2005 (interview 1).

Notes

1. A webcast of the panel discussion and the subsequent wide-ranging and lively debate is available at <http://www.communicatingastronomy.org/cap2005/programme.html>.
2. We would like to thank the interviewees, especially Claus Madsen, for sharing their insight.
3. Edmonds and Watzke (interview 1).
4. <http://www.spacetelescope.org/images/html/opo0124a.html>

References

- Dunwoody, S. 1986. *The Scientist as Source. In Science and Journalists— Reporting Science as News*, edited by S. M. Friedman, S. Dunwoody, and C. L. Rogers, 3-16. New York: Free Press.
- European Commission. 2005. Eurobarometer 63.1 Europeans, Science & Technology.
- Gregory, J. and S. Miller. 1998. *Science In Public: Communication, Culture, and Credibility*. Cambridge, Massachusetts: Basic Books.
- Kiernan, V. 2000. The Mars Meteorite: A case study in controls on dissemination of science news. *Public Understanding of Science* 9:15-41.
- Kvale, S. 1996. *Inter Views: An Introduction to Qualitative Research Interviewing*. Thousand Oaks, CA, Sage.
- Madsen, C. 2003. *Astronomy and Space Science in the European Print Media*. In *Astronomy Communication*, edited by A. Heck and C. Madsen. Dordrecht: Kluwer Academic Publishing.
- Marshall, E. 1998. ‘Embargoes: Good, Bad, or “Necessary Evil”?’ *Science* 282, 860-867.
- Nelkin, D. 1995. *Selling Science: How the Press Covers Science and Technology*. New York: Freeman.
- Peters, H. P. 1995. The interaction of journalists and scientific experts: co-operation and conflict between two professional cultures. *Media, Culture & Society* 17:31-48.
- Robson, I. 2005. Credibility panel discussion, In *Communicating Astronomy with the Public 2005: Proceedings from the ESO/ESA/IAU Conference 14-17 June 2005*, edited by I. Robson and L. L. Christensen, 162-163. Munich: ESA/Hubble.
- Russell, C. 1986. *The View from the National Beat. In Science and Journalists — Reporting Science as News*, edited by S. M. Friedman, S. Dunwoody, and C. L. Rogers: 81-94. New York: Free Press.
- Shaefer, B. E., K. Hurley, R. J. Nemiroff, D. Branch, S. Perlmutter, M. W. Schaefer, G. J. Gonsomagnio, H. Mcsween and J. Strom. 1999. Accuracy of press reports in astronomy. *Bulletin of American Astronomical Society* 31:1521.
- Shortland, M. and J. Gregory. 1991. *Communicating science: A handbook*. New York: Longman.
- Toy, J. 2002. The Ingelfinger Rule: Franz Ingelfinger at the New England Journal of Medicine 1967-77. *Science Editor* 25:195-198.
- Treise, D. and M. F. Weigold. 2002. Advancing science communication: A survey of science communicators. *Science Communication* 23:310-322.
- Valenti J. 1999. Commentary: How Well Do Scientists Communicate to Media? *Science Communication* 21:172-178.

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